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No. 1.

E. J. STONE, M.A., F.R.S., President, in the Chair.

Prof. H. G. van de Sande Bakhuyzen, The Observatory,
Leyden ;

Dr. W. Döllén, The Observatory, Pulkowa ;

Dr. W. Klinkerfues, The Observatory, Göttingen ;

Prof. H. Schultz, The Observatory, Upsala ; and

Prof. H. C. Vogel, The Observatory, Potsdam,

were balloted for, and duly elected Associates of the Society.

Robert Bryant, 11, King Street, Tower Hill, E.C. ;

Captain Arthur Lister Kaye, Manor House, Stretton-on-
Dunsmore, Rugby ; and

Jonadab Finch, Cheltenham,

were balloted for, and duly elected Fellows of the Society.

On certain Deviations from the Law of Apertures in Relation to Stellar Photometry ; and on the Applicability of a Glass Wedge to the Determination of the Magnitudes of Coloured Stars. By Professor C. Pritchard, F.R.S.

I believe the Society is aware that for some time past I have been engaged in the photometric examination of the relative brightness of the stars, by means of an instrument which, though not new in its several component parts, claims to be entirely new in their combination and mode of application. The first section of the work is now all but completed, viz. that which includes the relative brightness of all the stars from the Pole to the Equator,

which, in the catalogue of Heis, are estimated as brighter than the fifth order of brightness; together with a few other stars, possessing features of interest.

In the course of this research, some facts of considerable importance, and, as I think, possessing some novelty, having presented themselves, I take this opportunity of communicating them to the Society.

At an early stage of the inquiry, a doubt arose in my mind as to the perfect accuracy of the law which expresses the ratio of the amount of light successively transmitted by varying the aperture of the same object-glass. In my method of stellar photometry, the accuracy of this law was assumed as exact; and, indeed, formed a most material element in the reduction of the observations. For I had determined from several hundred measures, that a certain thickness of neutral-tinted glass, indicated by a measured interval along the wedge, reduced the light of a star by the same amount as that which is extinguished by halving the aperture of the object-glass; according to the generally accepted theory, this reduction of light is in the proportion of four to one. And in this way I was led to that method of reducing the wedge observations which has been already explained to the Society in my communication of November last, just twelve months ago.

I had reason to doubt the strict accuracy of this law, both from the nature of certain resulting deductions which forced themselves on my attention, and from the consideration that the complex structure of an object-glass consists virtually of a series of reversed wedges of two different kinds of glass differing in their thickness. Moreover, I had also been somewhat startled at conclusions arrived at by Dr. Wolff, of Bonn, in his photometrical observations published at Leipzig 1877. Dr. Wolff, in this really valuable and interesting work, states that he used a Zöllner Photometer, after having submitted it to the necessary tests. Among these tests he compared the ratio of the light transmitted from the same star through telescopic apertures varying approximately in the ratio of 3, 2, 1: the ratio of the lights so transmitted would, he expected, be in the ratio of 9, 4, 1; but as exhibited by the Zöllner Photometer, these ratios came out utterly, and as it seemed hopelessly, discordant, as will be seen from the exact figures given below.* Whether the causes which led to this most unexpected and discordant result, are rightly conjectured by Dr. Wolff or not, the fact remains; and, if unexplained or disregarded, would seem to suggest some preliminary doubts either as to the

* The exact diameters of the several apertures of the object-glass were respectively 37.4 mm., 25.9 mm., and 13.9 mm. From these figures Dr. Wolff calculates that the logarithmic ratio of the light of a star as seen with the two foregoing apertures of 37.4 mm. and 13.9 mm., should be 0.8766 [qu. 0.8597], whereas the ratio derived from actual observation was 0.3384. The numbers corresponding to these logarithms are respectively 7.53 [qu. 7.24] and 2.18: that is, the actual instrumental result was about $3\frac{1}{2}$ times less than it should have been on the generally adopted theory of apertures!

competency of the instrument, or as to the validity of the methods employed. I was quite sure that in the case of my own inquiries no such deviation from the generally received law of apertures could possibly exist; but, nevertheless, it now was more than ever necessary to determine, for the purposes of my own research, the exact ratio of the light transmitted by varying the aperture. I had in fact assumed, as other astronomers had assumed before me, that by halving the aperture, one-fourth part of the light was transmitted.

The late Mr. Johnson also undertook a series of experiments in nearly the same direction. He found that one of the halves of the heliometer objective transmitted more light than the other half, in the ratio of 1000 to 924; and further, that probably the central parts of the objective of the Oxford Heliometer are more transparent than the parts near to the circumference. The consequences of this latter result, however, he does not pursue further; but, notwithstanding his suspicions, he assumes throughout his investigations on the magnitude of certain stars, that the strict accuracy of the commonly received law of apertures is maintained.

Under these circumstances it was necessary, for the purposes of establishing the exactness of my photometry, to institute some crucial experiments, if such could be devised.

The first process which suggested itself to my mind was to ascertain, by means of my wedge, the relative amount of light transmitted 1° by the full aperture of 4 inches; 2° by the reduced aperture of 2 inches; and 3° by the full aperture, having a circular patch of two inches in diameter in the centre. This process must lead to the solution of the question before us, as will be obvious on a consideration of the case. But, instead of having recourse to this method of investigation, which, to be efficacious, would necessarily require much time and many observations, I thought it better to adopt an independent form of photometric examination, founded on the same principles of double refraction as those which have been so successfully applied by Prof. Pickering at Harvard College, and suggested in the *Observatory* of August 1882.

The method itself appears to me to be one of great beauty, readiness, and accuracy. It consists, mainly, in comparing the amount of light transmitted at different successive points on the wedge, by means of a double-image prism of quartz and a Nicol prism. The wedge was thus examined at every tenth of an inch throughout its extent, and its general uniformity was established to a degree which I had hardly ventured to expect. The conclusion I arrived at was, that on this hypothesis of practical uniformity, measures of light carefully made with the wedge ought not to lead to an error exceeding about the thirteenth of a magnitude. The full particulars of these experiments must be reserved until the publication of the complete memoir on the photometry of the brighter stars of the northern hemisphere is

communicated to the Society. For the present, the following results, and explanation of the method employed, may be interesting and sufficient. An opaque moveable screen was placed over the wedge, and in this screen two rectangular apertures were cut, whose centres were distant from each other by 0.3741 inches; the breadth of each of the apertures was 0.022 inches. Parallel light was then transmitted through the wedge at these two apertures, either from the Sun or from a gas lamp (and in a subsequent series of experiments through coloured glasses or coloured liquids); the ratio of the emergent lights through these two apertures was then measured by the double-image photometer, and the results are given in column 2 of the following table.

Wedge A, for use with a 4-inch Telescope.

Successive Positions of Screen. inches.	Mean Light Ratio.	Error of the Mean.	Equivalent Magnitude. (Pogson's scale.)	Error of the Mean in Magnitude.
From 0.3 to 0.9	1.919	0.026	0.71	0.015
1.0 „ 1.9	1.885	0.037	0.69	0.022
2.0 „ 2.9	1.901	0.031	0.70	0.019
3.0 „ 3.9	1.903	0.028	0.70	0.017
4.0 „ 4.9	1.889	0.027	0.69	0.017
5.0 „ 5.9	1.877	0.031	0.68	0.017

Wedge B, for use with a 3-inch Telescope.

From 0.5 to 1.4	2.443	0.029	0.970	0.012
1.5 „ 2.4	2.448	0.040	0.972	0.018
2.5 „ 3.5	2.445	0.036	0.971	0.016

Column 1. These figures mean (taking the first line as an example) that the wedge was photometrically tested at every tenth of an inch throughout the interval of wedge beginning at 0.3 in. from the end and ending at 0.9 in. towards the thicker part. Column 2 gives the mean of the ratio of the light transmitted at each successive tenth of an inch; as, for example, when the screen was moved from 0.3 in. to 0.4 in., to 0.5 in., up to 0.9 in. Column 4 is column 2 expressed in magnitude, assuming the light ratio for a single magnitude to be 2.512. Columns 3 and 5 explain themselves.

A further discussion of the results thus obtained leads also to the ratio of the light transmitted by the two telescopes employed when their linear apertures were halved. This ratio in the case of the 4-inch telescope is 3.918 : 1. In the 3-inch telescope this ratio is 3.921 : 1. These ratios approximate to the ratio of 4 : 1, hitherto I believe universally adopted; but, nevertheless, the error which would be thus introduced in the photometric reduction is by no means inconsiderable. For example, in the comparison of two stars differing by only three orders of brightness, the error thus

introduced would amount to nearly a tenth of a magnitude, an amount of error which is not admissible in the accurate photometry aimed at, and shown to be attainable by my method. Indeed, this deviation from exactness was sufficient to compel me to modify the reduction of the observations of several hundreds of stars. Moreover, it is of the nature of a systematic error, and would probably become greatly increased and very serious, if the aperture of the telescope were still further reduced to those much smaller dimensions (one-seventh of an inch for example) which have been recommended by preceding astronomers. Further, these investigations seem to suggest that it would be impossible to apply any method of telescopic apertures alone, to the photometry of the stars, unless the idiosyncracies of the particular object-glass employed were accurately ascertained by some independent method of photometry.

While I was engaged in the foregoing inquiry into the capacity of the wedge as regards the amount and uniformity of its absorption of ordinary light, I availed myself of the opportunity of examining its effects on lights of different colours; and this I did with the expectation of ascertaining how far the wedge method of photometry could be relied on in the case of coloured stars, whether single or double. With this view I interposed coloured glasses and other coloured media between the source of light and the wedge, and I ascertained, as the result, that within the limits of our unavoidable errors of observation the same thickness of wedge practically absorbed the same amount of light, whether its colour be red, orange, yellow, green, or blue. I confess that I was agreeably surprised at this result, although I think that, in part at least, it might have been anticipated; because, in the process of extinguishing the light of stars through the wedge, there had been no consciousness in the mind of the observer, of different colours in the case of particular stars. If this result be confirmed, as I think it will be, by still more numerous observations, it is obvious that in the wedge we possess an instrument applicable to the photometry of coloured stars. It may here be interesting to give a few numerical results.

The mean absorptive power of the wedge B for different moderately coloured lights, obtained by the process referred to in Table I., is as follows:—

White light from Sun	...	...	...	2'445 = 0'97 mag.
Red light	...	...	...	2'432 = 0'96
Orange	...	...	...	2'436 = 0'97
Green	...	...	...	2'426 = 0'96
Blue	...	...	...	2'421 = 0'96

The characters of these various media were examined *spectroscopically*, with the following results. The band of absorption extended, in the case of the

Red medium; from wave-length	527 to w.l. 468, i.e. E to $\frac{1}{2}$ (F + G)
Orange medium;	518 ,, 420 ,, b to G
Green medium;	691 ,, 590 ,, B to D
Blue medium;	760 ,, 653 ,, A to C

In still further confirmation of the applicability of this method of stellar photometry I may place a few observations of coloured double stars made at Oxford with the wedge now referred to, in juxtaposition with observations of the same stars made at Harvard College by Professor Pickering with his double image photometer.

Star's Name.	Colours of Components.		Difference of Wedge (Oxford)	Magnitude. Double Image (Harvard)	Σ 's estimation.
	A	B			
η Cassiopeia ...	<i>y</i>	<i>p</i>	3.77	3.85	3.6
ψ Piscium ...	<i>w</i>	<i>w</i>	0.22	0.20	0.3
ζ Piscium ...	<i>w</i>	<i>w</i>	0.86	0.96	1.1
γ Andromedæ .	<i>gl</i>	<i>b</i>	2.72	2.85	2.0
α Piscium ...	<i>g</i>	<i>b</i>	0.97	0.90	1.4
Castor ...	<i>grsh</i>	<i>grsh</i>	0.75	0.82	1.0
α Can. Ven. ...	<i>w</i>	<i>w</i>	2.33	2.56	2.2
ϵ Boötis ...	<i>v.y</i>	<i>v.b</i>	2.46	2.43	3.3
ζ Lyrae ...	<i>gr.w</i>	<i>gr.w</i>	1.11	1.38	1.1
ϵ Lyrae ...	<i>gr.w</i>	<i>bl.w</i>	1.01	0.96	1.7
δ Lyrae ...	<i>v.w</i>	<i>v.w</i>	0.36	0.23	0.3
θ Serpentis* ...	<i>y</i>	<i>y</i>	0.33	0.87	0.1
β Cygni ...	<i>y</i>	<i>b</i>	1.74	2.14	2.1
β Cygni (Nov.6)			1.82		
γ Delphini ...	<i>gl</i>	<i>bg</i>	0.93	0.99	1.0

There remains another question for consideration, viz. the effect of the atmosphere on the light of the stars as seen at varying altitudes. In my first communication to the Society I cursorily touched upon this point, and I thought I had satisfied myself that, for stars observed at altitudes exceeding 50° , the difference in the amount of the atmospheric extinction of light is so small that it can be allowed for or even disregarded without appreciable error; but that at lower altitudes the effects are so variable, and seem to depend upon elements so inconstant, at all events in our climate, that very sensible errors may easily be admitted from this cause. Dr. Seidel's tables do probably represent

* Looking at Professor Pickering's individual measures, it seems probable that one of the components of this star may be variable.

average results, but do not seem to be available in individual cases. Dr. Wolff goes so far as to state that, in his particular locality, he regards even the azimuth of a star to be an element in the amount of stellar light extinguished. This may be the case at Oxford also, possibly owing to the confluence of so many streams of water. And this suspicion is by no means to be disregarded in reference to our own method of observation; because this method, in part, consists in not observing stars necessarily on the meridian, but in such positions as shall best secure a general uniformity in the altitudes of all the stars observed. Considering the difficulty and importance of this branch of the subject, and the necessity of varying both the meteorological and the geographical conditions under which the observations should be made, I purpose to undertake a journey to the south, probably to Cairo, in order to collect additional information for the solution of the problem, and to render this contribution to stellar photometry as complete as possible.

In what has been herein advanced, regarding

- (1) The caution that is now shown to be necessary before adopting a method of photometry by varying telescopic apertures;
- (2) The possibility of securing practical accuracy of stellar photometry in the use of a wedge of neutral-tinted glass;
- (3) The possibility of correctly measuring thereby the relative brilliancy of coloured stars, whether single or double,

I hope something useful has been added to our astronomical methods of research.

On Observations of Comets 1881 II. & III., of Wells's Comet, and of the Great Comet (b) 1882, made at the Royal Observatory, Cape of Good Hope. By David Gill, LL.D., Her Majesty's Astronomer at the Cape of Good Hope.

The following papers contain all the observations of comets made at this Observatory since 1880, with the exception of a few observations of Wells's Comet, made with the heliometer, and those of the present Great Comet, which are not yet reduced.

In April 1881, when on a brief visit to England, I took with me, and forwarded to Messrs. Repsold, of Hamburg, the tube of the 8½-foot equatorial, for the purpose of having a new micrometer and new illuminating arrangements made for it.

During my absence, and whilst the tube was with Messrs. Repsold, Tebbutt's Great Comet appeared, and it was admirably

observed with the heliometer, by my friend and guest Dr. Elkin. His observations of this comet form the first part of the present communication.

About the beginning of September 1881 it became desirable to secure observations of Schärerle's Comet in the southern hemisphere, and these observations were of necessity first made with the heliometer. The opportune arrival of the Repsold micrometer prevented the discontinuity of the series of observations, as the comet, at the end of September, was becoming too faint for the limited light-grasp of the heliometer. The exquisite bright wire illumination of the new Repsold micrometer, capable of the most perfect modulation, permitted observations to be made whenever the comet was visible in a dark field. The comet was followed till Oct. 18, when it only became visible in twilight a few minutes before it set behind Table Mountain. The last observations were made with the mountain's ridge in the edge of the field of view.

The observations made by myself are indicated by the letter G, those by Dr. Elkin by the letter E.

I have thought it desirable to publish Mr. Finlay's observations of Wells's Comet without waiting for meridian observations of the comparison stars. These determinations can equally well be made at some of the numerous northern observatories, and many of the stars have probably been already observed in connection with the zone observations of the *Astronomische Gesellschaft*.

The observations of the Great Comet of the present year are accompanied by notes from the different observers.

Royal Observatory,
Cape of Good Hope :
1882, Oct. 9.

Heliometer Observations of Comet 1881 II. (Tebbutt), made by W. L. Elkin, Ph.D.

	Cape Mean Time.	Distance.	Obs.	Position Angle.	Obs.	$\Delta\alpha$	$\Delta\delta$
1881.	h m s						
May 31	6 19 24	2057"3	4	177° 27'6	4	+ 1' 44"7	-34' 15"2
June 1	6 8 51	1578"3	2				
	3 5 53 47	3561"8	4	96 40'7	4	+65 48'6	- 6 54'2
	3 6 27 4	1495"2	2	215 1'9	2	-15 56'8	-20 24'4
	4 5 59 57	3544"0	4	354 2'0	4	- 6 48'4	+58 44'7
	8 5 48 9	4586"6	2				
	9 5 31 18	2514"8	4	30 58'3	4	+22 26'6	+35 56'3
	9 18 3 8	1393"6	4	38 15'9	4	+14 51'8	+18 14'2

	Mean Places of Comparison Stars.				Authority.	Red. to App. Place.	
^{1881.}							
May 31	75° 44' 41".7	-29° 1' 59".8	2 Merid. Obs.		+2".5	-1".5	
June 1	75 44 41.7	-29 7 59.8	"		+2.6	-1.3	
3	75 6 34.0	-26 18 49.6	Stone		+4.3	-0.3	
3	76 28 35.0	-26 3 35.6	Stone		+4.4	-0.9	
4	76 28 35.0	-26 3 35.6	Stone		+4.5	-0.7	
8	78 23 13.9	-18 15 28.1	3 Merid. Obs.		+8.7	-0.7	
9	76 53 47.3	-16 20 50.6	Stone		+9.6	0.0	
9	77 8 43.6	-14 44 46.8	3 Merid. Obs.		+10.3	0.0	

Apparent Places of Comet.

May 31	75° 46' 28".9	+ [9.980] _p	-29° 42' 16".5	+ [9.673 _n] _p
June 1		[9.973]		[9.665 _n]
3	76 12 26.9	[9.965]	-26 25 44.1	[9.665 _n]
3	76 12 42.6	[9.967]	-26 24 0.9	[9.711 _n]
4	76 21 51.1	[9.962]	-25 4 51.6	[9.684 _n]
8		[9.943]		[9.711 _n]
9	77 16 23.5	[9.934]	-15 44 54.3	[9.727 _n]
9	77 23 45.7	[9.931 _n]	-14 26 32.6	[9.725 _n]

p being the horizontal parallax, expressed in seconds of arc, and the numbers in brackets logarithms.

Heliometer Measures of Comet 1881 III. (Schäberle).

	Obs.	Star of Comp.	Dis- tance.	No. of Bisec.	Position Angle.	No. of Bisec.	$\Delta\alpha$	$\Delta\delta$
^{1881.} Aug. 31	E	α	173".4	4	192° 30'.8	4	^m -0 2'.58	- 2' 49".2
31	G	α	207.1	4	182 43.3	4	-0 0.68	- 3 26.8
Sept. 1	E	β	3352.4	4	280 8.4	4	-3 44.45	+ 9 50.2
1	G	β	3275.6	4	278 16.3	4	-3 40.46	+ 7 51.2
3	G	γ	1613.2	4	289 21.6	4	-1 42.06	+ 8 54.8
3	E	γ	1552.7	4	287 30.8	4	-1 39.29	+ 7 47.2
6	E	ϵ	4091.3	4	275 19.6	4	-4 31.58	+ 6 19.8
6	E	δ	5027.4	4	228 16.6	4	-4 10.16	-55 45.9
7	E	ζ	3070.4	4	260 32.5	4	-3 22.06	- 8 24.6
7	G	ζ	3042.4	4	259 7.7	4	-3 19.34	- 9 33.8
8	G	η	2972.0	4	77 27.7	4	+3 13.90	+10 45.2
8	E	η	2991.3	4	78 43.7	4	+3 16.08	+ 9 44.7
9	E	θ	926.8	4	164 32.4	4	+0 16.58	-14 53.3
9	G	θ	993.9	4	163 32.0	4	+0 18.87	-15 53.2

1881.	Obs.	Star of Comp.	Dis- tance.	No. of Bisec.	Position Angle.		No. of Bisec.	$\Delta\alpha$		$\Delta\delta$	
					°	'		m	s	'	"
Sept. 12	G	ι	1265'0	4	80	7'6	4	+ 1	24'31	+ 3	36'9
12	E	ι	1279'5	4	81	59'3	4	+ 1	25'72	+ 2	58'3
14	G	κ	2671'5	4	355	9'2	4	- 0	15'41	+ 44	21'9
14	E	κ	2628'4	4	355	27'7	4	- 0	14'20	+ 43	40'2
15	E	λ	1910'3	4	126	52'1	4	+ 1	44'63	- 19	6'2
15	G	λ	1941'4	4	127	27'3	4	+ 1	45'51	- 19	40'6
19	G	μ	2414'7	4	128	11'4	4	+ 2	11'96	- 24	53'0
19	E	μ	2450'9	4	128	34'3	4	+ 2	13'24	- 25	28'1
21	G	ν	2303'6	4	264	25'2	4	- 2	40'89	- 3	44'0
21	E	ν	2297'8	4	263	35'0	4	- 2	40'24	- 4	16'8
23	G	ξ	611'3	4	160	57'1	4	+ 0	14'11	- 9	37'8
23	E	ξ	641'1	4	161	1'0	4	+ 0	14'75	- 10	6'2
24	G	o	3329'5	4	301	50'3	4	- 3	21'22	+ 29	16'4
24	E	o	3305'7	4	301	24'9	4	- 3	20'74	+ 28	43'0
27	E	π	364'7	4	277	17'7	4	- 0	25'99	+ 0	46'3
27	G	π	356'2	4	272	42'1	4	- 0	25'56	+ 0	16'7

*Apparent Places of Comet 1881 III. (Schüberle), deduced from
Heliometer Measures.*

Cape Mean Time.			α			δ		
1881.	h	m	s	h	m	s		
Aug. 31	7	9	56	13	22	35'89 + [8'720] p	+ 14	21 56''3 + [9'792 n] p
31	7	15	17	13	22	37'79 [8'724]	+ 14	21 18'7 [9'787 n]
Sept. 1	6	39	23	13	30	0'15 [8'682]	+ 11	30 48'2 [9'800 n]
1	6	53	39	13	30	4'14 [8'697]	+ 11	28 49'2 [9'795 n]
3	6	30	4	13	42	46'32 [8'658]	+ 6	14 5'6 [9'780 n]
3	6	41	15	13	42	49'09 [8'671]	+ 6	12 58'0 [9'779 n]
6	6	40	38	13	57	31'46 [8'664]	- 0	22 40'6 [9'741 n]
6	7	11	51	13	57	36'98 [8'698]	- 0	25 14'6 [9'743 n]
7	6	38	14	14	1	29'72 [8'661]	- 2	15 18'5 [9'727 n]
7	6	55	0	14	1	32'44 [8'681]	- 2	16 27'7 [9'731 n]
8	6	46	34	14	5	7'65 [8'674]	- 4	0 8'0 [9'719 n]
8	7	1	42	14	5	9'83 [8'690]	- 4	1 8'5 [9'721 n]
9	7	17	4	14	8	28'41 [8'706]	- 5	38 37'4 [9'715 n]
9	7	24	58	14	8	30'70 [8'720]	- 5	39 37'3 [9'721 n]
12	6	43	17	14	16	38'04 [8'679]	- 9	46 2'4 [9'674 n]
12	6	56	59	14	16	39'45 [8'695]	- 9	46 41'0 [9'681 n]
14	6	49	24	14	21	5'36 [8'694]	- 12	5 12'6 [9'660 n]
14	7	4	18	14	21	6'57 [8'709]	- 12	5 54'3 [9'670 n]

Nov. 1882.¹

at the Cape of Good Hope.

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Cape Mean Time.

1881.				α			δ		
	h	m	s	h	m	s	°	'	"
Sept. 15	7	5	54	14	23	5.40	−13	8	40.7
15	7	20	50	14	23	6.28	−13	9	15.1
19	6	53	57	14	29	43.63	−16	42	45.7
19	7	9	31	14	29	44.91	−16	43	20.8
21	7	18	49	14	32	30.93	−18	13	27.0
21	7	35	43	14	32	31.58	−18	13	59.8
23	7	51	16	14	35	0.40	−19	34	45.8
23	8	4	52	14	35	1.04	−19	35	14.2
24	7	10	55	14	36	7.41	−20	11	7.2
24	7	26	21	14	36	7.89	−20	11	40.6
27	7	16	4	14	39	17.81	−21	53	27.6
27	7	38	33	14	39	18.24	−21	53	57.2

p being the horizontal parallax of the comet, expressed in seconds of arc, and the numbers in brackets logarithms.

Measures of $\Delta\alpha$ and $\Delta\delta$ of Comet III. (Schäuberle), from Comparison Stars, with the $8\frac{1}{2}$ ft. Equatorial.

Cape Mean Time.			Obs.	Star.	$\Delta\alpha$		Cape Mean Time.			$\Delta\delta$
1881.	d	h m s			m	s	h m s	'	"	
Sept.	30	7 18 13	G	a	−2	18.56 (6)	7 12 3	− 0	56.4 (3)	
Oct.	1	7 10 9	E	b	−0	6.68 (12)	7 9 48	− 7	2.7 (6)	
	2	7 14 45	E	c	−0	31.00 (6)	7 19 10	+ 4	7.5 (1)	
	3	7 17 49	E	d	−1	3.21 (4)	7 18 44	+ 14	50.7 (5)	
	4	7 11 51	E	d	−0	14.63 (6)	7 19 57	−10	11.1 (5)	
	7	7 12 14	E	e	+0	51.36 (8)	7 25 33	− 2	52.8 (5)	
	10	7 22 44	G	f	+0	13.21 (8)	7 23 22	− 2	2.1 (4)	
	11	7 19 41	E	g	+0	22.01 (12)	7 20 12	− 6	45.3 (6)	
	12	7 27 40	E	h	+0	17.08 (9)	7 21 41	− 2	22.5 (4)	
	14	7 31 7	G	i	+2	47.98 (10)	7 35 9	+ 1	36.1 (6)	
	16	7 24 59	G	l	+0	17.50 (3)	7 19 2	− 5	58.7 (2)	
	17	7 30 47	G	m	−2	18.18 (10)	7 22 30	− 2	44.5 (4)	
	18	7 32 3	G	n	+3	3.17 (3)	7 27 21	+ 6	49.5 (1)	
	18	7 32 3	G	o	+2	56.60 (3)	7 27 21	+ 3	14.1 (1)	

Notes.—Oct. 2. Comet faint, through fog, for pointing in declination uncertain.

16. Comet only barely visible.

Apparent Places of Comet 1881 III. (Schüberle), from Observations with the 8½-ft. Equatorial.

Cape Mean Time.				α			Cape Mean Time.				δ		
1881.	h	m	s	h	m	s	h	m	s	°	'	"	
Sept. 30	7	18	13	14	42	6.94 + [8.772] p	7	12	3	-23	23	3.5 + [9.639 $_n$] p	
Oct. 1	7	10	9	14	42	59.10 [8.771]	7	9	48	23	50	41.0 [9.637 $_n$]	
	2	7	14	45	14	43	51.57 [8.776]	7	19	10	24	17	32.6 [9.652 $_n$]
	3	7	17	49	14	44	42.07 [8.779]	7	18	44	24	42	59.1 [9.654 $_n$]
	4	7	11	51	14	45	30.66 [8.780]	7	19	57	25	8	0.9 [9.659 $_n$]
	7	7	12	14	14	47	52.58 [8.787]	7	25	33	26	17	44.1 [9.674 $_n$]
	10	7	22	44	14	50	6.78 [8.794]	7	23	22	27	21	24.8 [9.680 $_n$]
	11	7	19	41	14	50	49.94 [8.796]	7	20	12	27	41	27.0 [9.678 $_n$]
	12	7	27	40	14	51	33.94 [8.797]	7	21	41	28	1	11.5 [9.684 $_n$]
	14	7	31	7	14	52	58.31 [8.799]	7	35	9	28	39	5.5 [9.662 $_n$]
	16	7	24	59	14	54	21.04 [8.801]	7	19	2	29	15	27.5 [9.675 $_n$]
	17	7	30	47	14	55	2.46 [8.802]	7	22	30	29	32	42.6 [9.662 $_n$]
	18	7	32	3	14	55	42.53 [8.802]	7	27	21	29	49	52.2 [9.660 $_n$]
	18	7	32	3	14	55	42.51 [8.802]	7	27	21	29	49	52.2 [9.660 $_n$]

p being the horizontal parallax of the comet in seconds of arc, and the numbers in brackets logarithms.

Mean Right Ascensions and Declinations of Comparison Stars for Comet 1881 III. (Schüberle), from Observations with the Transit Circle at the Royal Observatory, Cape of Good Hope, in the year 1882.

<i>Heliometer Stars.</i>						<i>Equatorial Stars.</i>											
α 1882.0			δ 1882.0			α 1882.0			δ 1882.0								
h	m	s	°	'	"	h	m	s	°	'	"						
α	13	22	39.40	(3)	+ 14	24	34.42	(3)	b	14	43	6.65	(3)	- 23	43	42.08	(4)
β	13	33	45.48	(3)	+ 11	20	47.31	(3)	a	14	44	26.36	(3)	- 23	22	10.86	(3)
γ	13	44	29.21	(3)	+ 6	5	1.18	(3)	c	14	44	23.44	(3)	- 24	21	43.91	(3)
δ	14	1	47.90	(3)	+ 0	30	22.73	(3)	d	14	45	46.18	(3)	- 24	57	53.51	(3)
η	14	1	54.53	(3)	- 4	11	0.64	(3)	e	14	47	2.13	(3)	- 26	14	55.02	(3)
ϵ	14	2	3.81	(3)	- 0	29	8.72	(3)	i	14	50	11.28	(3)	- 28	40	45.48	(3)
ζ	14	4	52.53	(3)	- 2	7	1.81	(3)	f	14	49	54.50	(3)	- 27	19	26.67	(3)
θ	14	8	12.60	(3)	- 5	23	51.29	(3)	g	14	50	28.86	(3)	- 27	34	45.45	(3)
ι	14	15	14.50	(3)	- 9	49	45.45	(3)	h	14	51	17.78	(3)	- 27	58	52.80	(4)
κ λ	14	21	21.54	(3)	- 12	49	39.98	(3)	n	14	52	40.32	(3)	- 29	56	45.73	(3)
μ	14	27	32.47	(3)	- 16	17	57.53	(3)	o	14	52	46.87	(3)	- 29	53	10.30	(3)
ξ	14	34	47.11	(3)	- 19	25	13.28	(3)	l	14	54	4.49	(3)	- 29	9	32.78	(3)
ν	14	35	12.61	(3)	- 18	9	47.48	(3)	m	14	57	21.59	(3)	- 29	30	1.99	(3)
$\omicron$	14	39	29.45	(3)	- 20	40	27.59	(3)									
π	14	39	44.14	(3)	- 21	54	17.87	(3)									

The figures in brackets denote the number of days on which each star was observed on the meridian.

Comet 1882 (Wells).

The observations of this comet were made by Mr. W. H. Finlay, first assistant, with the 7-inch equatorial.

The comet was first found at the Cape on June 14, by the help of an ephemeris computed by Messrs. Finlay and Elkin, from Dr. Bigourdan's elements. On that date one transit of the comet and of γ *Geminorum* was taken across the ring micrometer. Unfortunately the changes of the refractions at the low altitude caused the star to pass nearly across the middle of the ring, so that the difference of declination is of very little value. This observation gives

$$\begin{array}{rcl} & \text{d} & \text{h} \quad \text{m} \quad \text{s} \\ \text{June 14} & 5 \quad 47 \quad 44\cdot4 & \text{C.M.T.} \end{array} \quad \begin{array}{rcl} & \text{h} & \text{m} \quad \text{s} \\ \alpha = & 6 \quad 14 \quad 30\cdot29 & + 0\cdot0560p \\ \delta = + & 16' \quad 23\cdot5'' & - 0\cdot589p \end{array}$$

where p denotes the comet's horizontal parallax in seconds of arc.

When first seen on June 14, the comet had a large diffused head without any marked condensation, and a tail about 2° long in the twilight. The centre of this diffused head was observed throughout, but on two occasions, when the definition was better than usual, a bright stellar nucleus was seen in the preceding part of the head.

On June 17 the tail was considerably curved towards the south, and the northern side and edge were much brighter and better defined than the southern.

After July 24 the entries were made by Dr. Elkin at a given signal, on account of the faintness of the comet.

Moonlight prevented observations after August 16.

Date.	Cape Mean Time.	d' (R.A.) $\delta - \star$ h m s	No. of Comparison.	Parallax in R.A.	d (Decl.) $\delta - \star$ " "	No. of Comparison.	Parallax in Decl.	Comparison Star.
1882, June 17								
	5 47 25.4	+4 13.05	10	+0.532p	+6 20.00	2	-0.618p	Arg. + 15°, 1431
	5 46 14.4							"
	6 2 50.8	-4 37.96	1	+0.546p	+5 2.13	1	-0.595p	Arg. + 15°, 1494
	6 14 35.7				-0 30.74	1	-0.591p	Arg. + 15°, 1482
	6 11 3.5							Arg. + 15°, 1541
18	5 51 10.3	+0 24.86	23	+0.525p	2 21.73	16	-0.615p	"
	6 1 43.2							Arg. + 15°, 1601
19	6 6 56.4	+0 23.51	10	+0.531p	+5 35.41	8	-0.627p	"
	6 6 42.2				-1 38.84	6	-0.617p	Arg. + 15°, 1673
20	6 16 19.2							"
	6 23 47.4	-2 35.69	20	+0.537p	+2 38.29	5	-0.623p	Arg. + 14°, 1806
21	6 17 33.1							"
	6 20 32.5	-1 25.08	14	+0.525p	+3 26.19	6	-0.624p	Arg. + 14°, 1882
23	6 10 38.7	+0 37.75	12	+0.496p	+1 22.45	10	-0.649p	"
	6 30 6.0				+0 24.55	12	-0.645p	Arg. + 13°, 1981
24	6 2 57.1	+0 58.91	28	+0.476p				"
	6 4 20.0							Arg. + 14°, 1917
25	6 13 26.4							"
	6 18 22.3	-0 38.61	32	+0.487p				Arg. + 13°, 1981

Date.	Cape Mean Time.	α' (R.A.) $\delta - \star$	No. of Com- parison.	Parallax in R.A.	α (Decl.) $\delta - \star$	No. of Com- parison.	Parallax in Decl.	Comparison Star.
1882, June 26	h m s	m s						
	6 30 48.1	-3 20.47	25	+0.494 p	-0 14.25	4	-0.637 p	Arg. + 13°, 2019
	6 30 0.7	-0 5.65	4	+0.465 p	+0 43.37	4	-0.647 p	" * <i>a</i>
29	6 15 15.7	+2 32.86	30	+0.475 p	+6 35.76	6	-0.642 p	Arg. + 12°, 2021
30	6 33 41.1	+0 46.59	24	+0.446 p	-5 37.08	4	-0.649 p	Arg. + 12°, 2049
	6 31 25.4	-0 42.14	28	+0.468 p	+1 25.64	10	-0.637 p	Arg. + 12°, 2053
July 1	6 33 43.3	-1 15.62	32	+0.439 p	-6 9.58	6	-0.648 p	Arg. + 12°, 2076
	6 41 50.0	-2 8.60	4	+0.462 p	+2 59.98	3	-0.636 p	Arg. + 11°, 2108
2	6 18 30.9	-1 49.49	28	+0.461 p	-5 26.78	8	-0.629 p	Arg. + 10°, 2157
	6 24 35.0	+0 10.59	31	+0.434 p	+5 17.53	10	-0.637 p	" ρ Leonis
8	6 38 43.1	-2 24.92	20	+0.440 p	+3 15.96	4	-0.633 p	Arg. + 9°, 2384
	6 46 3.0							"
9	6 54 28.2							
	6 55 54.4							
10	6 37 55.4							
	6 38 13.0							
	6 43 52.2							
	6 43 42.7							

Date.	Cape Mean Time. h m s	d' (R.A.) $\delta' - \star$ m s	No. of Com- parison.	Parallax in R.A.	d (Decl.) $\delta' - \star$	No. of Com- parison.	Parallax in Decl.	Comparison Star.
1882, July 11	6 37 11.7							
	6 37 34.2	+ 0 18.28	20	+ .0428 <i>p</i>	+ 2 8.92	12	— .635 <i>p</i>	Arg. + 3°, 9295
12	6 43 58.9							"
	6 44 55.2	+ 1 19.19	12	+ .0467 <i>p</i>	— 3 31.69	4	— .619 <i>p</i>	* <i>b</i>
	7 9 0.5							
	7 5 3.6	+ 0 12.04	10	+ .0437 <i>p</i>	+ 6 20.33	6	— .630 <i>p</i>	Arg. + 9°, 2409
13	6 32 43.5							"
	6 33 9.7	+ 0 22.15	20	+ .0417 <i>p</i>	+ 0 59.53	10	— .634 <i>p</i>	Arg. + 8°, 2423
14	6 59 34.0							"
	7 0 53.2	— 0 3.63	11	+ .0458 <i>p</i>	— 2 13.02	8	— .621 <i>p</i>	Arg. + 8°, 2437
15	6 46 45.0							"
	6 49 46.2	— 2 43.37	15	+ .0442 <i>p</i>	— 3 28.34	6	— .625 <i>p</i>	Arg. + 8°, 2454
19	7 16 19.9							"
	7 14 6.3	+ 0 16.72	5	+ .0474 <i>p</i>	— 5 5.19	6	— .607 <i>p</i>	Arg. + 7°, 2434
20	7 10 57.9							"
	7 11 11.5	+ 0 4.91	10	+ .0470 <i>p</i>	+ 3 29.96	8	— .608 <i>p</i>	Arg. + 7°, 2440
21	6 55 36.2							"
	6 55 58.6	— 0 44.39	15	+ .0449 <i>p</i>	— 0 32.70	8	— .612 <i>p</i>	* <i>c</i>
22	6 37 30.8	— 0 14.94	5	+ .0422 <i>p</i>				"
	6 43 55.7				+ 0 47.33	2	— .615 <i>p</i>	Arg. + 7°, 2451
								"

Nov. 1882.

at the Cape of Good Hope.

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Date.	Cape Mean Time. h m s	d' (R.A.) ° - * m s	No. of Com- parison.	Parallax in R.A.	d (Decl.) ° - * " "	No. of Com- parison.	Parallax in Decl.	Comparison Star.
1882, July 23	7 10 7.6					4	-604 p	Arg. + 6°, 2445
24	7 10 11.0	+2 40.75	2	+0.470 p	+0 25.76			"
	7 22 41.4	+1 4.93	20	+0.486 p		6	-597 p	Arg. + 6°, 2465
26	7 26 14.0				-0 39.78	8	-599 p	"
	7 12 54.6		15		+2 44.44			Arg. + 6°, 2485
27	7 12 36.3	-1 6.59		+0.476 p	-3 44.81	4	-595 p	"
	7 19 4.3		6	+0.490 p				Arg. + 6°, 2490
Aug. 1	7 23 27.0	+0 1.65			-2 8.74	8	-596 p	"
	6 50 51.9	-0 17.65	20	+0.455 p	+1 50.02			Arg. + 5°, 2562
2	6 50 35.5					8	-580 p	"
	7 36 19.9	+2 9.63	20	+0.511 p	-0 1.68	4	-591 p	Arg. + 5°, 2573
3	7 35 22.7				-1 45.62			"
	6 56 50.3	+0 41.00	16	+0.480 p	+4 8.84	8	-584 p	Arg. + 4°, 2572
4	7 5 24.6							"
	6 40 41.2	-0 10.60	16	+0.448 p				Arg. + 4°, 2585
8	6 39 43.1							"
	6 58 49.3	+2 17.75	15	+0.476 p				"
	6 56 17.1							"

Date.	Cape Mean Time.	α' (R.A.) $\delta - \star$	No. of Comparison.	Parallax in R.A.	δ (Decl.) $\delta - \star$	No. of Comparison.	Parallax in Decl.	Comparison Star.
1882, Aug. 11	h m s 7 29 25.1	+ 1 6.46	12	+ 0.529p	- 0 55.62	4	- 57.4p	Arg. + 3°, 2632
12	7 42 48.2							"
	7 12 31.0				+ 3 30.91	8	- 57.6p	Arg. + 3°, 2638
14	7 12 17.5	- 0 7.26	8	+ 0.502p				"
	6 26 25.3				- 1 46.63	4	- 57.7p	Arg. + 3°, 2645
	7 8 24.8	+ 0 28.00	13	+ 0.502p				"
16	7 1 45.1				- 1 51.19	4	- 57.3p	Arg. + 3°, 2663
	7 18 29.3	- 1 29.96	20	+ 0.516p				"

Approximate places of the stars α , b and c are

Mag.	α	δ
	h m s	'
* a ...	8 49 15	+ 13 25.0
* b ...	10 40 57	+ 9 7.6
* c ...	{ Arg. + 7.2443	Arg. + 7.2443
	+ 2 ^m 34 ^s .6	- 4' 51"

Notes.

July 14. Comet faint through cloud.

24. From 7^h 15^m to 7^h 18^m C.M.T., the comet was passing a star of about 10.5 mag. For some time it was almost impossible to separate them, but the comet seemed to pass to the south of the star.

Aug. 8, 14. Comet extremely faint.

4, 8, 16. The declinations given by Argelander for these stars seem to be 1' too large.

Meridian Observations of the Great Comet (b) 1882 with the Transit Circle of the Royal Observatory, Cape of Good Hope.

	App. R.A.			App. Decl.	Observer.
	h	m	s		
Sept. 17	11	31	49.06	+ 1° 37' 25".3	Gill
18	11	22	33.76	+ 0 28 50.3	"
22	11	1	59.00	- 2 30 5.7	"

Heliometer Observation of Great Comet (b) 1882.

	Cape Mean Time.	App. R.A.	App. Decl.	Observer.
	h	m	s	
Sept. 8	17 13 58	144° 59' 52".1	- 0° 56' 30".1	Elkin

Notes on the Great Comet (b) 1882. By David Gill, LL.D., Her Majesty's Astronomer at the Cape of Good Hope.

The comet was first seen by Mr. Finlay, chief assistant, on Sept. 7, about 17^h, when on the way to his house, after observing an occultation of 5 *Canceri*.

It was then a conspicuous object, the nucleus appearing to the naked eye as bright as a star of the third magnitude. Returning at once to the equatorial, Mr. Finlay secured comparisons with an 8th magnitude star, but from an error in reading off the Declination circle the comparison star was not at first properly identified, and hence the erroneous motion in declination which I telegraphed to the Astronomer Royal.

The following morning an excellent series of measures of position angle and distance from *Hydræ* were secured by Dr. Elkin with the heliometer; and Mr. Finlay, with the equatorial, obtained comparisons with an 8th mag. star. My own hands were closely tied in the evening with heliometer measures for stellar parallax [it was then the epoch of maximum parallax for *a Centauri* with my comparison stars] and with measures of *Victoria* and *Sappho* extending far into the early morning. Notwithstanding these engagements, after two hours' sleep I made an attempt on Sept. 9 to secure heliometer observations, but was only able to get a rough place from the circle readings whilst the comet was visible for a few minutes between clouds. A period of cloudy and rainy weather now set in, during which the comet could only be occasionally seen before sunrise by glimpses between clouds, and it became obvious that if observations were to be made at all, some exceptional means must be adopted to secure them—means that would enable an absolute place to be secured from a single pointing whenever opportunity offered.

Accordingly I resolved to dismount the photoheliograph, to

shift its portable observatory to a site commanding the eastern horizon, and to mount in it the great Indian theodolite.*

The work was begun on the morning of the 15th during torrents of rain, and by eleven o'clock at night the theodolite was mounted and adjusted. The following morning I was rewarded by two glimpses of the comet, and two observations of its difference in altitude and azimuth from the Sun.

The morning of Sunday, the 17th (civil reckoning), was cloudy till after sunrise, but improved in a few hours sufficiently to permit a long series of altazimuth observations to be made. In the afternoon it became evident that the comet could be followed to conjunction with the Sun's limb, and this observation was actually secured both by Mr. Finlay and Dr. Elkin.† The observation is described in the accompanying notes by the observers themselves.

The following morning, at Simon's Bay, I was astonished at the brilliancy of the comet as it rose behind the mountains on the eastern side of False Bay. There was not a cloud in the sky, only a merging into a rich yellow that fringed the blackish blue of the distant mountains, and over the mountains and amongst the yellow an ill-defined mass of golden glory rose with a beauty I cannot describe.

The Sun rose a few minutes afterwards, but to my intense surprise the comet seemed in no way dimmed in brightness, but becoming instead whiter and sharper in form as it rose above the mists of the horizon. I left Simon's Bay and hurried back to the observatory, pointing out the comet in broad daylight to the friends I met by the way. It was only necessary to shade the eye from direct sunlight with the hand at arm's-length to see the comet with its brilliant white nucleus, and dense white, sharply-bordered tail of quite $\frac{1}{2}^{\circ}$ in length.

On arrival at the observatory I heard of all the wonders of the previous day, and in turn pointed out the comet, a brilliant object when viewed by shading the Sun from the eye by interposing the roof of the observatory portico.

I secured a complete meridian observation of the comet, and ten minutes afterwards the Sun's transit.

Numerous observations with the altazimuth were also secured.

* This instrument was constructed by Troughton and Simms, under the superintendence of Colonel Strange, for the great trigonometrical survey of India. It has been kindly lent to me, by General Walker, for some special researches. The telescope has $3\frac{1}{2}$ inches aperture, the horizontal circle is 3 feet in diameter, and the vertical circle 2 feet, reading by 5 and 4 microscopes respectively.

† I myself lost this unprecedented observation by a visit to Simon's Bay, for the purpose of meeting Captain Morris, R.E., as chief of the British Transit of Venus Expedition to Brisbane. Captain Morris had written by a previous mail expressing a strong wish to see me in reference to the Geodetic Survey of South Africa about to be undertaken. The prevalence of small-pox in Cape Town induced the owners of the "*Liguria*" (by which Captain Morris was a passenger) to order her to touch at Simon's Bay instead of Cape Town, and I was thus absent during the whole of Sunday, the 17th.

The following day (Sept. 18, astronomical reckoning), and on Sept. 22, I also obtained meridian observations. The nucleus on the 17th and 18th was as sharply defined and as easily observable as a star of the first magnitude seen by daylight, and the form of the head was also clearly visible. Drawings of the head were made the same afternoon with the 6-inch equatorial. On Sept. 22, the nucleus, as seen in the transit circle, was comparable with a star of the third magnitude seen by daylight, and the rest of the head was barely distinguishable. Cloudy weather prevailed between Sept. 18 and 22, and for some time after the 22nd, preventing my obtaining a longer meridian series.

Advantage has been taken of every available opportunity to secure extra meridian observations since the 22nd.

The results of such determinations of the place of the comet as are immediately available are given in the accompanying paper. The appearance of the comet in the early morning has been, and still continues to be, most grand and imposing.

With a direct vision prism, whose plane of dispersion was placed at right angles to the direction of the comet's tail, a complete yellow monochromatic image of the head, and of a great portion of the tail, was easily visible for a week after perihelion, but this can no longer be seen now.

The changes in the form of the nucleus are of extreme interest, as also is the formation of a delicate outer envelope, whose axis is different from that of the tail.

The description of these changes, and copies of the drawings that have been made, will form the subject of a future communication.

The Great Comet (b) 1882—Disappearance at the Sun's Limb.
By W. H. Finlay, B.A.

On Sept. 7, at 17^h Cape mean time, I saw a comet with a large head and a tail about a degree in length. I secured a number of comparisons of the comet and Arg. -0° , 2229 with the 6-inch equatorial. On the 8th the brightness of both head and tail had increased very considerably. The southern edge of the tail was sharp and brighter than any other part, while the northern half seemed to stop short at some distance from the head. A nucleus was seen, situated towards the south of the centre of the head. I got several comparisons with Arg. -0° , 2256. Bad weather, and the want of comparison stars in the morning light, prevented my getting more observations with the 6-inch before perihelion passage.

On Sunday, Sept. 16 to 17, the comet was visible all day, and Dr. Elkin and myself made a large number of observations with the great Indian theodolite; unfortunately cloud prevented

my observing the comet on the meridian. In the afternoon I watched the comet with the 6-inch equatorial, and power 110, using a neutral-tint wedge on account of the glare of the Sun. I did not expect that the comet would reach the Sun before night, but they were rapidly approaching one another, and about 4.40 p.m. I found the Sun's limb visible at the edge of the field. The silvery light of the comet presented a striking contrast to the reddish-yellow of the Sun; the tail could only be traced to a very short distance now. After waiting some minutes I was about to observe differences of R.A., but the increasing rate at which the comet was closing up rendered it certain that it would reach the Sun in a very short time. By keeping the Sun's limb at the edge of the field I was able to follow the comet continuously right into the boiling at the limb. I lost sight of it suddenly at

h m s
4 50 58 Cape M.T.,

when the Sun's limb was boiling all about it. I fancied I caught a glimpse of it 3^s later, but was not sure. I then examined the Sun's disk very carefully, but could not see the slightest trace of the comet. I swept round the limb before the Sun disappeared behind the Lion Hill, but saw nothing. The sun was then very low and the definition bad.

Two measures with the micrometer about half an hour before the disappearance gave 4'' for the diameter of the comet's disk.

Royal Observatory, Cape of Good Hope :
1882, Oct. 9.

Observations of the Great Comet (b) 1882. By W. L. Elkin, Ph.D.

(Communicated by Mr. Gill.)

My first view of the comet was on Sept. 8. It then appeared to the unassisted eye about as bright as a star of the third or fourth magnitude, with a straight tail about $2\frac{1}{2}^{\circ}$ in length. The position angle of the tail, as measured at its origin with the heliometer at 4^h sidereal time, was $253^{\circ}.1$. The breadth of the coma at the nucleus was estimated at 40'' to 50'', the nucleus itself being a nebulous mass strongly condensed in the centre, some 10'' or 15'' in diameter, and admitting of very accurate observation with the heliometer as such. The southern edge of the tail was sharply defined for a considerable distance, but the northern one faded away some 12' to 15' from the head. The colour of the comet's light struck me as remarkably *white*, perhaps contrasting it from recollection with comet *Wells*, which was of a brilliant golden hue.

The morning sky was always completely clouded (with the exception of some momentary breaks, Sept. 9 and 15) till

Sept. 16, when a minute or two of clear sky enabled the comet to be brought into the field of the heliometer, and throughout the day it was always a brilliant object in the telescope whenever free from clouds, and this without the slightest precautions being necessary. The forenoon was very cloudy, and only a few pointings with the great Indian theodolite were obtained; after meridian passage it was more favourable. As the comet approached the Sun in the afternoon I made unsuccessful attempts to measure its position with the heliometer from the Sun's limb; it could then only be seen with a low power (60), and disappeared on being brought up to the limb when still at some distance from this latter. Screening down the Sun with wire gauze screens was tried, but the amount of false light thereby produced rather impeded than forwarded the visibility of the comet in the Sun's vicinity; it soon, however, became apparent that the comet would be followed up close to the Sun, as seen directly through one of the half lenses, and favoured by the clouds I actually observed it to disappear among the undulations of the Sun's limb at

h m s
4 50 52 Cape M.T.,

the observation being considered at the time as accurate as an occultation of a star, say of the fourth magnitude, at the bright limb of the full Moon. The moment noted was when the last trace of the comet was suspected amidst the boiling of the limb: 4^s before it was still plainly visible. The undulations were, however, already some 5'' in magnitude, and the comet was probably still some fraction of this distance from the Sun's true limb. The observation was made with one of the half lenses of the heliometer, and a piece of cardboard was placed in the focus of the telescope, covering one-half of the field, so that but a small segment of the Sun was visible, but this in the centre of the field. A red glass sunshade was used, and it appeared to me that the intrinsic brilliancy of the nucleus, and of a small portion of the emanations from it, could scarcely have been inferior to that of the Sun's surface itself.

Immediately after noting the times, I changed the low power (60) with which the previous observation was made for one of 180, and carefully scrutinised the place where the comet had disappeared, and its probable path, for about a quarter of an hour without being able to detect any traces of a body, dark or bright, on the face of the Sun. The definition was, however, with increasing zenith distance, becoming worse and worse, and I noted at the time that possibly an object of an apparent diameter of 1'' or less might have escaped unnoticed, to which I may add that at the time of disappearance at the limb the nucleus was estimated to be still some 5'' in diameter.

At that time it was not possible to say with any certainty whether the comet was passing behind the Sun, or between us

and the Sun, the available observations not admitting of any reliable conclusions being deduced from them. As this latter proved to have been the case, the fact of a comet's invisibility on the Sun's face, to ordinary instrumental means at least, lends an additional interest to the observation. I hope, however, in America, with a higher Sun, the rare occasion will not have been lost.

The post-perihelion development of the comet has been replete with interest, and of great grandeur, and has been followed with as much assiduity as the exceptionally unfavourable weather would permit.

Elements of the Great Comet (b) 1882. By W. H. Finlay, B.A.,
and W. L. Elkin, Ph.D.

T	...	...	Sept. 17.2242, G.M.T.	
ω	...	...	69° 32' 8"	} Mean Equinox 1882 ^o .
S ₈	...	...	345 59 35	
i	...	...	141 58 59	
log q	...	...	7.888881	

These elements are founded on two meridian observations on Sept. 17, 22, and extra-meridian ones on Sept. 28, aberration and parallax being taken into account. They represent the middle place and two other observations as follows :—

				<i>Comp. — Obs.</i>	
				$d\lambda$	$d\beta$
Sept.	8	...	...	—8"	—20"
	22	...	...	0	+ 5
Oct.	3	...	...	0	+ 24

They also give for the distance of the comet from the centre of the Sun at the moment when we saw it disappear at the limb on the afternoon of Sept. 17 :—

$$963''.2,$$

which is only 5''.5 in excess of the tabular value of the Sun's semi-diameter.

The outstanding errors in the extreme latitudes are certainly greater than the uncertainties in the star places or in the observations will account for, and seem to point to a slight insufficiency of the parabolic hypothesis.

It will be seen at once that the elements bear a strong resemblance to those of the great comets of 1843 and 1880. In physical appearance, however, this comet differs totally from that of

1880, and (as far as can be gathered from the accounts) only resembles the one of 1843 in the point of extreme brilliancy at perihelion.

*Royal Observatory,
Cape of Good Hope :
1882, Oct. 9.*

The Great Comet (b) 1882. By F. C. Penrose.

I have attempted to work out the orbit of the comet graphically; and although I know I have not succeeded fully, yet I have arrived at results which, I trust, may be thought respectable. They are, at any rate, entirely independent of any published elements.

T	...	...	...	...	Sept. 17·23,
Longitude of ascending node					348° 20′,
Inclination	...	...	...		37° 15′,

the orbit being an ellipse with a period of about 480 days. The above elements were got from observations subsequent to perihelion, and up to Oct. 11. When I try to connect them with later observations, I see reason to come nearer to Mr. Hind's elements, which give for the node and the inclination respectively

346° 6′ 58″

and

37° 58′ 59″.

I have not yet made any determination of the orbit before perihelion, but from such observations as have come to hand, and others taken very shortly after perihelion, I think I may venture to add that the graphical work suggests the probability of the node having been swept several degrees backwards in longitude between the contact with the Sun's limb recorded by Mr. Gill on the 17th, and the subsequent observations, say up to Sept. 23.

Observations of Comets a, b, c, 1882, made at the Royal Observatory, Greenwich.

(Communicated by the Astronomer Royal.)

The observations of Comet *a* with the Naylor equatorial, of Comet *b* with the East equatorial, and of Comet *c* with the South-east equatorial, were all made by taking transits over two cross wires at right angles to each other, and each inclined 45° to the parallel of declination.

Observations of Comet a, 1882, with the Naylor Equatorial. Aperture 6 inches.

Greenwich Mean Solar Time.			Obs.	♂ - *		N.P.D.	No. of Comp.	Apparent R.A.			Apparent N.P.D.			Star.	
1882. d	h	m		m	s	'	"	h	m	s	°	'	"		
Apr. 20	12	42	W.C. & T.	+ 3	37.40	+ 4	56.8	4	19	15	27.52	32	35	2.7	<i>a</i>
				- 2	41.69	+ 0	16.2	4	19	15	25.87	32	35	10.3	<i>b</i>
28	12	49	T.	+ 1	1.77	+ 12	18.9	5	20	7	3.51	24	14	35.5	<i>c</i>
	12	56		- 4	46.67	+ 7	21.6	3	20	7	3.04	24	14	20.1	<i>d</i>
30	11	14	T.	+ 1	18.97	+ 8	33.2	2	20	26	1.34	22	15	5.2	<i>e</i>
				- 1	20.97	- 16	8.4	2							<i>f</i>
	11	59	H.	- 1	15.46	- 18	7.1	1							<i>f</i>
	12	30		+ 1	53.19	+ 5	27.3	2	20	26	35.56	22	11	59.3	<i>e</i>
May 2	10	59	T.	+ 5	32.94	- 23	12.9	2	20	49	24.12	20	17	39.0	<i>g</i>
	10	55		- 2	28.91	- 11	43.0	1							<i>h</i>
	11	8		- 3	58.15	- 13	22.3	1	20	49	32.35	20	17	6.1	<i>i</i>
4	11	39	T.	+ 2	24.39	+ 8	50.7	2	21	19	23.08	18	28	31.2	<i>k</i>
				- 1	40.27	+ 1	38.0	2	21	19	21.93	18	28	33.9	<i>l</i>

Mean Places of the Comparison Stars.

Star, Star's Name.		R.A. 1882.0			N.P.D. 1882.0			Authority.	
		h	m	s	°	'	"		
<i>a</i>	54 Draconis	19	11	48.74	32	29	54.0	Greenwich Catalogue, 1860.	
<i>b</i>	Groomb. 2827	19	18	6.22	32	34	42.4	Radcliffe, 1845	
<i>c</i>	Oeltz. Arg. 20152	20	6	0.58	24	2	6.5	Oeltz. Arg. (N), 1842	
<i>d</i>	„ 20313	20	11	48.58	24	6	48.5	„	
<i>e</i>	Arg. Z. +67°-1248	20	24	41.29	22	6	22.3	Bonn Observations, vol. v.	
<i>f</i>	Anonymous								
<i>g</i>	Groomb. 3301	20	43	50.17	20	40	42.9	Radcliffe, 1845	
<i>h</i>	Anonymous								
<i>i</i>	Groomb. 3359	20	53	29.57	20	30	19.6	Radcliffe, 1845	
<i>k</i>	Oeltz. Arg. (N) 22131	21	16	57.91	18	19	32.4	Oeltz. Arg. (N), 1842	
<i>l</i>	„ 22261	21	21	1.45	18	26	47.9	„	

April 30 and May 4.—Comet very faint.

The observations are not corrected for refraction or parallax.

Nov. 1882.

made at the Royal Observatory.

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Observations of Comet a, 1882, S.P. with the Transit Circle.

Greenwich Mean Solar Time.					Obs.	R.A.			N.P.D. (corrected for Refraction and Parallax).			Remarks.
1882.	d	h	m	s		h	m	s	°	'	"	
May	12	8	52	15	H.	0	14	19.68	-15	32	38.46	Exceedingly faint
	13	9	13	27	A.D.	0	39	31.76	-15	53	49.23	Very faint
	15	9	52	17	T.	1	26	20.62	-17	8	19.55	Very faint indeed
	17	10	24	14	L.	2	6	16.08	-18	59	51.63	
	19	10	48	58	H.	2	38	58.01	-21	20	56.21	Very faint, cloudy
	20	10	58	56	T.	2	52	53.50	-22	40	17.78	Very faint indeed
	23	11	20	37	A.D.	3	26	28.27	-27	5	53.64	Much brighter
	24	11	25	40	B.	3	35	28.72	-28	42	0.19	Very faint, cloudy
	25	11	29	48	H.	3	43	33.70	-30	21	16.78	
	27	11	35	52	A.D.	3	57	31.60	-33	48	34.86	About 5th magnitude
	28	11	37	58	T.	4	3	34.20	-35	36	30.51	
	29	11	39	31	H.	4	9	4.19	-37	27	7.99	Cloudy

Observations of Comet b, 1882, with the East Equatorial. Aperture 6.7 inches.

Greenwich Mean Solar Time.				Obs.	R.A.		♌-*	N.P.D.	No. of Comp.	Apparent R.A.			Apparent N.P.D.			Star.	
1882.	d	h	m		m	s		°	'	"	h	m	s	°	'	"	a
Oct.	25	17	13	A.D.	+1	46.75	-12	5.9	2								a
		17	17		+1	41.12	-8	58.3	4		10	5	20.70	107	24	33.7	b
		17	22		-0	17.75	+0	10.7	2		10	5	17.96	107	25	1.6	c
	29	17	8	A.D.	+0	34.00	+3	25.9	2		9	59	27.15	108	53	57.1	d
		17	12		-3	11.66	-5	21.5	3		9	59	22.06	108	54	1.4	e
		17	20		+0	39.50	+2	0.6	1		9	59	25.06	108	54	18.3	f
	30	17	20	H.	+1	12.80	+4	16.9	2								g
		17	10		+0	26.82	+5	47.3	1								h
		17	30		-3	53.85	+8	22.0	1		9	57	55.41	109	16	31.4	i
Nov.	1	15	41	T.	+0	57.50	+12	34.6	3		9	54	45.83	110	0	17.7	k
		15	48		-2	21.75	+8	59.3	2		9	54	44.10	110	0	22.8	l
	7	16	45	H.	+1	27.62	-5	14.1	2								m
		16	37		-2	9.50	-1	37.2	1								n
		16	52		+5	11.50	-6	14.8	1		9	44	36.05	112	6	37.0	o
	8	17	23	A.P.	-1	58.75	+6	45.7	2								p
					-3	34.00	-2	4.7	2								q
	9	17	32	T.	+1	22.25	-0	51.8	4		9	40	38.38	112	48	27.9	r
					+1	3.50	-8	17.5	2		9	40	38.40	112	48	23.7	s
					+1	39.75	+7	53.9	2								t
	17	40		A.D.	+1	3.25	-8	59.7	2		9	36	40.10	113	28	5.5	u
	17	48			-0	29.10	+4	42.1	5		9	36	38.84	113	28	10.0	v
	17	50			+0	46.50	+5	37.2	1								w
	17	56			-3	1.00	-0	48.2	2								x

Mean Places of the Comparison Stars.

Star.	Star's Name.	R.A. 1882'o.			N.P.D. 1882'o.			Authority.
		h	m	s	o	'	"	
<i>a</i>	Anonymous							
<i>b</i>	Lalande 19797	10	3	37.01	107	33	22.4	Lalande
<i>c</i>	Oeltz. Arg. 10428	10	5	33.15	107	24	41.1	Oeltz. Arg. (S), 1850
<i>d</i>	Lalande 19699	9	58	50.47	108	50	21.8	Oeltz. Arg. (S)
<i>e</i>	" 19770	10	2	31.05	108	59	13.4	"
<i>f</i>	" 19696	9	58	42.88	108	52	8.3	"
<i>g</i>	Anonymous							
<i>h</i>	"							
<i>i</i>	Lalande 19765	10	1	46.56	109	7	59.9	Oeltz. Arg. (S)
<i>k</i>	" 19559	9	53	45.55	109	47	33.9	Lalande
<i>l</i>	" 19641	9	57	3.09	109	51	14.2	"
<i>m</i>	Anonymous							
<i>n</i>	"							
<i>o</i>	Oeltz. Arg. 10075	9	39	11.56	112	12	43.1	Oeltz. Arg. (S)
<i>p</i>	Anonymous							
<i>q</i>	"							
<i>r</i>	Oeltz. Arg. 10084	9	39	31.86	112	56	32.5	Oeltz. Arg. (S)
<i>s</i>	" 10076	9	39	13.09	112	49	10.9	"
<i>t</i>	Anonymous							
<i>u</i>	Oeltz. Arg. 10011	9	35	33.74	113	36	56.5	Oeltz. Arg. (S)
<i>v</i>	" 10043	9	36	55.83	113	23	19.1	"
<i>w</i>	Anonymous							
<i>x</i>	"							

Nov. 1.—Comet very faint, cloudy.

Nov. 8.—Comet very faint at times.

Nov. 9.—Nucleus of comet very diffused and faint.

Nov. 11.—The comet appeared a faint patch of light; very difficult to observe; sky thick.

The observations are not corrected for refraction or parallax.

Observation of Comet *b*, 1882, with the Altazimuth.

From a double observation of Comet *b* made on the morning of Oct. 23 with the altazimuth, with the graduated face of the vertical circle right and left, the following position corrected for refraction and parallax was obtained:—

Greenwich Mean Solar Time.				Observer.	R.A.			N.P.D.
1882. d	h	m	s		h	m	s	
Oct. 22	16	49	17	H.	10	9	30.98	106 15 28.6

Observations of Comet b, 1882, with the Transit Circle.

Greenwich Mean Solar Time.				Obs.	R.A.			N.P.D. (corrected for Refraction and Parallax).			
1882. d	h	m	s		h	m	s	°	'	"	
Nov. 16	17	41	26	L.	9	26	10.00	115	3	34.0	Cloudy
17	17	35	11	A.D.	9	23	50.53	115	21	39.9	Very faint; a difficult observation

Observations of Comet c, 1882, with the S.E. Equatorial. Aperture 12.8 inches.

Greenwich Mean Solar Time.			Obs.	R.A.		δ - *	N.P.D.	No. of Comp.	Apparent R.A.			Apparent N.P.D.	Star.		
1882. d	h	m		m	s	'	"		h	m	s	°	'	"	
Sept. 27	16	28	M	+ 2	9.80	+ 2	49.2	1	7 46	47.90		86	28	20.2	a
				+ 0	49.85	+ 3	7.2	1	7 46	47.78		86	28	17.6	b
27	15.58		M	+ 0	16.01	- 0	28.5	13	7 46	44.24		86	26	58.3	c
				+ 0	12.05	+ 8	5.2	13	7 46	45.34		86	26	55.7	d

Mean Places of the Comparison Stars.

Star.	Star's Name.	R.A. 1882.0.			N.P.D. 1882.0.			Authority.
		h	m	s	°	'	"	
a	W.B. VII.-1289	7	44	35.37	86	25	24.6	Weisse's Bessel (1)
b	" 1324	7	45	55.20	86	25	3.9	"
c	" 1337	7	46	25.51	86	27	20.2	"
d	" 1339	7	46	30.57	86	18	43.9	"

The observations are not corrected for refraction or parallax.

The initials W.C., A. D., M., T., L., H., A. P., and B., are those of Mr. Christie, Mr. Downing, Mr. Maunder, Mr. Thackeray, Mr. Lewis, Mr. Hollis, Mr. A. Pead, and Mr. Bennett.

Royal Observatory, Greenwich:
1882, Nov. 18.

Observations of the Great Comet (b), 1882, made at the Melbourne Observatory. By R. L. J. Ellery, F.R.S.

A brilliant comet, first seen in Australia on the morning of Sept. 9, has since been observed here on every occasion when the very cloudy weather which has prevailed would permit.

It became so bright just before perihelion that it was seen at noon with the naked eye within four degrees of the Sun on the 17th, and was observed on the meridian with the transit circle on three days. It is now (Sept. 25) again visible in the early morning. On the 24th it was easily seen with a 4½-in. telescope three hours after sunrise. Its tail was seen 15° long in the bright dawn, and was about 1° wide at the end. This morning, although markedly less bright, it was seen in the same telescope 20 minutes after sunrise.

From observations obtained on the 9th, 13th, and 16th, Mr. E. J. White, chief assistant, computed a first approximation to an orbit, which is here given:—

T	...	...	Sept. 17.175
π	...	...	$275^{\circ} 12'$
Ω	...	...	353 38
i	...	...	38 10
$\log q$	...	...	7.6906

Motion retrograde.

The exceedingly small perihelion distance, as well as the other elements of this comet, exhibit a decided similarity to that of 1843.

The positions hitherto obtained are attached.

Places of the Great Comet (b), 1882, from Observations made with the North Equatorial, aperture $4\frac{1}{2}$ in., and the Transit Circle of the Melbourne Observatory.

Melbourne M. T. Sept.	Greenwich M. T. Sept.	Obs.	No. of Meas.	R.A. m s	Comet - Star. N.P.D. ' "	Apparent R.A. h m s	Comet. R.A. ° ' "	Apparent N.P.D.	Compared with
d h m s	d h m s								
9 17 24 51.4	9 7 44 56.6	W	4	+ 1 21.37	+ 1 5.82	9 45 46.41	90 53 36.0		Lamont 2277
13 17 37 21.5	13 7 57 26.7		2	+ 4 31.11	+ 15 41.02	10 28 48.49	90 17 49.2		30 Sextantis, Cape 5739
14 23 10 13.7	14 13 30 18.9					10 45 53.34	89 55 47.1		Meridian Transits
15 23 22 36.6	15 13 42 41.8					11 2 14.89	89 29 39.2		"
16 23 39 0.3	16 13 59 5.5					11 22 37.75	88 47 55.2		"

The meridian transit of Sept. 15 was observed with great difficulty, the comet being obscured by cloud.

Melbourne Observatory:

1882, Sept. 25.

Observations of the Great Comet (b), 1882, made at the Sydney Observatory. By H. C. Russell, B.A.

I enclose herewith meridian observations of the comet on four days. They were taken with a Simms' Transit Circle, recently made, and having a 6-in. (clear) objective. The observations have been corrected for all instrumental errors and for refraction. I may mention that the correct longitude for Sydney, $10^{\text{h}} 4^{\text{m}} 50^{\text{s}}.8$, is given in the *Nautical Almanac* for 1885; that for 1884 and previous years give the old longitude, which was incorrect. The comet was reported to me on Sept. 7 by Mr. Springwell, chief officer of the steamer *Caraki*. I saw it first on the 8th, but the daylight made it impossible to get stars for comparison with the equatorial. I have examined it with the spectroscope, and find a very bright continuous spectrum without the usual comet lines; but there is one bright line in the yellow which, so far as I have yet been able to ascertain, is coincident with the sodium line. I have not been able to see any dark lines in the continuous spectrum.

The comet presents a magnificent spectacle in the morning now. On Sept. 17 I watched it most of the day; it was like a bright star near the Sun, and with the telescope was seen to have a well-defined nucleus and coma with concentric layers, the outer one being the best defined.

Observations of the Great Comet (b), 1882, taken on the Meridian at Sydney.

1882.	R.A.	N.P.D.
	h m s	
Sept. 18	11 25 33.25	89 10 50.35
19	11 18 7.72	90 3 48.63
20	11 12 19.68	90 51 12.84
21	11 7 30.81	91 34 51.39

Sydney Observatory:
1882, Oct. 5.

Observations of the Great Comet (b) 1882, made at Windsor, New South Wales. By John Tebbutt.

About noon on the 8th inst. the Government astronomer at Melbourne telegraphed to me "a large comet reported due east at 4h. a.m." Other messages were received during the day from different parts of this colony. From the information thus afforded I was enabled to get observations on the mornings of the 9th and 10th. The nucleus was very large and remarkably brilliant, and the tail about three or four degrees in length. Owing to the strong twilight there were no stars visible sufficiently near to the comet to be within reach of the threads of the filar-micrometer, and I was, therefore, obliged to have recourse to

a square bar-micrometer. By this means I made comparisons on both mornings with star B.A.C., 3303. The transits were observed on opposite sides of the square, and are, therefore, not so satisfactory as I could wish. The following are the results corrected for differential refraction and the comet's proper motion.

	d	h	m	s	d	h	m	s
Windsor Mean Time, 1882, Sept. ...	8	17	54	52	9	17	49	45
Mean R.A. of Star, 1882 ^o ...			9	33			9	33
Reduction to App. R.A. for date ...	+			1.84	+			1.86
Difference R.A. (Comet—Star) ...	+		3	15.90	+		11	56.19
Apparent R.A. of Comet ...			9	37			9	45
Mean N.P.D. of Star 1882 ^o ...			90	36			90	36
Reduction to App. N.P.D. for date ...	+			10.8	+			10.7
Difference N.P.D. (Comet—Star) ...	+		21	8.0	+		16	57.9
Apparent N.P.D. of Comet ...			90	57			90	53
Log. Factor for Parallax in R.A. ($\frac{p}{P}$)				—8.7115				—8.7187
Log. Factor for Parallax in N.P.D. ($\frac{q}{P}$)				+9.7365				+9.7370
Number of Comparisons ...				4				2

The star's mean place has been deduced from the following authorities:—Schjellerup, Radcliffe Observations, 1858, and *Annales de l'Observatoire Royal de Bruxelles*, Cat. 1874. Up to the present time no further observations could be made, in consequence of fog and cloud, but as the comet is fast approaching conjunction with the Sun, it is probable that it will be visible in the evenings in the west.

Windsor, N. S. Wales:

1882, Sept. 15.

Observations of the Great Comet (b), 1882. By A. V. Nursing Row.

A comet is now visible in the eastern heavens before sunrise, and is so conspicuous to the naked eye as to attract general attention. It presents a bright planetary disk, surrounded by nebulosity. On applying higher magnifiers this appearance vanishes, the centre of the head not being occupied by a star-like point.

The head has a border of light surrounding it on the side towards the Sun, and continued round on each side of the tail.

The disk has been undergoing changes of form and apparent diameter for twelve days. The length of the bright part of the tail is between 7° and 8°, above which are narrow rays or streaks of light extending more than 12°—concave towards the south,

and shaped like the tusk of an elephant, the thick part being at the greatest altitude. Observing the comet with the naked eye at the seaside the whole tail took nearly an hour to rise.

Oct. 7.—In telescopic observations some vibration was observed at the head, and for some portion of the tail near the head for only a few seconds. This, we first thought, was owing to some irregular shaky motion of the equatorial, and closely examined the instrument. It was, however, found to be all right, being driven by clockwork, and no accident could be traced in the going of the instrument. The condition of the atmosphere was unusually fine and clear, and no wind. This morning the declination of the comet was 11° nearly; right ascension, $10^{\text{h}} 16^{\text{m}} 31^{\text{s}}$ nearly. Approximate daily variation deduced from the observations—in right ascension, $3^{\text{m}} 5^{\text{s}}$; in declination, $+ 34'5$ or $+ 35'$ nearly.

Our Hindoo astronomers predicted the appearance of a comet in the southern hemisphere in their printed calendar for the present year. As to the identity, they gave no other particulars except that it would possess a bright copper colour like the rising moon, and a long tail. The name given by them to their predicted comet is “Silpacam.”

*Observatory, Daba Gardens,
Vizagapatam:
1882, Oct. 8.*

Elements of the Orbit of Comet 1881 III. (Schüberle).

By Henry T. Vivian.

From the three positions of Comet III., 1881, observed by Mr. Tebbutt, Sept. 20 and 29, and Oct. 8 (*Monthly Notices*, vol. xlii., p. 263), I have computed the following parabolic elements:—

$$T = 1881, \text{ August } 22.4093, \text{ G.M.T.}$$

$$\left. \begin{array}{l} \pi = 334^{\circ} 56' 47'' \\ \Omega = 97^{\circ} 11' 49'' \end{array} \right\} \begin{array}{l} \text{Apparent Equinox,} \\ 1881, \text{ Sept. } 29. \end{array}$$

$$i = 39^{\circ} 37' 1''$$

$$\log q = 9.8015958$$

Motion retrograde.

A comparison with the middle place (computed—observed) gave—

$$\Delta L = + 3''8; \quad \Delta l = - 12.2.$$

The observations were corrected for aberration, and the longitude of Windsor was taken from the *Nautical Almanac* for the year.

London: 1882, Nov. 2.

13^m 24^s by the former, the conjunction must have occurred on Aug. 5 at 0^h 44^m.

In September the conjunction took place about 1^d 5^h later than that computed. I made observations on Sept. 13 and 15, and on Sept. 17 the markings were observed by Mr. A. Stanley Williams at Brighton:—

				Red Spot on C.M.	White Spot on C.M.
				h m	h m
1882, Sept.	13	...	..	12 28	13 28
	15	...	...	14 6	14 36
	17	...	...	15 38 5	15 47

On Sept. 17 the white spot followed the red 8·5 minutes, so that it must have arrived at conjunction on Sept. 18 at 7^h. Near the epoch of the last conjunction at the end of October I obtained the following results:—

				Red Spot on C.M.	White Spot on C.M.
				h m	h m
1882, Oct.	25	..	...	16 59	18 32
	29	...	...	10 20	10 52
	30	...	...	16 10	16 22
Nov.	1	...	...	17 54	17 40

On Oct. 30 at 16^h 22^m the white spot *followed* the red twelve minutes, so that the conjunction is indicated for Oct. 31, 13^h 51^m.

On Nov. 1 at 17^h 40^m the white spot *preceded* the red fourteen minutes, so that the phenomenon is shown for Oct. 31, 15^h 36^m. The mean of the two values is Oct. 31, 14^h 43^m, which, I believe, must be very near the truth, as the pair of observations agree very closely, and were made under extremely favourable circumstances. This conjunction has, therefore, occurred within about two hours of the epoch given last January, and thus the period of 44^d 10^h 42^m 13^s·3 derived from observations extending from Nov. 19, 1880, to Dec. 24, 1881, during which the white spot performed nine revolutions, is well confirmed. The observations of successive conjunctions show that there is a considerable departure from the average period in several cases. Thus the conjunction of Sept 26, 1881, 7^h 32^m, and Nov. 10, 11^h 3^m, give a period as long as 45^d 3^h 31^m, whereas that of Sept. 18, 1882, 7^h, and Oct. 31, 14^h 43^m, was only 43^d 7^h 43^m, showing a difference of nearly two days. Since Nov. 19, 1880, which was the first conjunction of the two spots ever observed here, the great velocity of the white spot has enabled it to complete 16 revolutions of *Jupiter* relatively to the position of the red spot. The number of rotations performed during the entire period from Nov. 19, 1880, 9^h 23^m, to Oct. 31, 12^h, is 1,719 for the red spot and 1,735 for the white spot.

The red spot has grown extremely faint, and its early disappearance seems very possible. On the other hand, the brilliant white spot fully maintains the striking appearance it presented in 1880, and gives promise of remaining in view for a considerable time. Should the two markings continue visible during the ensuing year, they may be observed at or near conjunction at the following times:—

			h	m	s
1883. Jan. 28	...	...	10	3	0
Mar. 13	...	...	20	45	13
Apr. 27	...	...	7	27	27
June 10	...	...	18	9	40
July 25	...	...	4	51	53
Sept. 7	...	...	15	34	7
Oct. 22	...	...	2	16	20
Dec. 5	...	...	12	58	33

The bright spot is very variable. There is a wide range in its maxima and minima. On three occasions I have failed to see any sign of it in my 10-inch Browning Reflector, though, at the time of maximum, I have seen it distinctly with a $2\frac{1}{2}$ -inch Ramsden object glass. This spot is the central one, and the largest of three near together on the equatorial border of the great southern belt, and is the brightest and most conspicuous of its class. It must not be confused with many other varieties of white spots distributed over the surface of *Jupiter*, which are far less permanent and, in some instances, give different periods of rotation.

Ashley Down, Bristol:

1882, Nov. 2.

The Fireball Radiants of August 9-11. By W. F. Denning.

In addition to the brilliant shower of Perseids which returns every year on August 9-11 there are many other meteor streams which, though of minor character, are yet distinctly marked, and occasionally supply fireballs of considerable size. I recently examined a large number of meteor catalogues, and projected the paths of many fireballs recorded on the nights of August 9-11, and, as may be readily inferred, the great majority of these proved to be Perseids, though several other radiants were well indicated by the directions of their flights. I found good showers from points near γ *Cephei*, α *Oygni*, γ *Andromedæ*, γ *Capricorni*, and α *Draconis*; also more doubtful positions at $100^\circ + 63^\circ$, $249^\circ + 48^\circ$, $341^\circ + 34^\circ$, $257^\circ + 13^\circ$, $192^\circ + 79^\circ$, $253^\circ \cdot 20^\circ$,

355°-8°, and 337°-28°. The two former I regard as particularly well established, and they correspond with showers of ordinary meteors. It may, therefore, be interesting to refer to them in detail, as they are very likely to come under repeated observation in future years.

I. The shower near γ Cephei is at 335°+73°. The paths of sixteen fireballs were found to indicate this position very exactly. Of these the observed flights of thirteen are shown on the accompanying diagram. They were chiefly observed by members of the Italian Meteoric Association in 1872, but the shower is

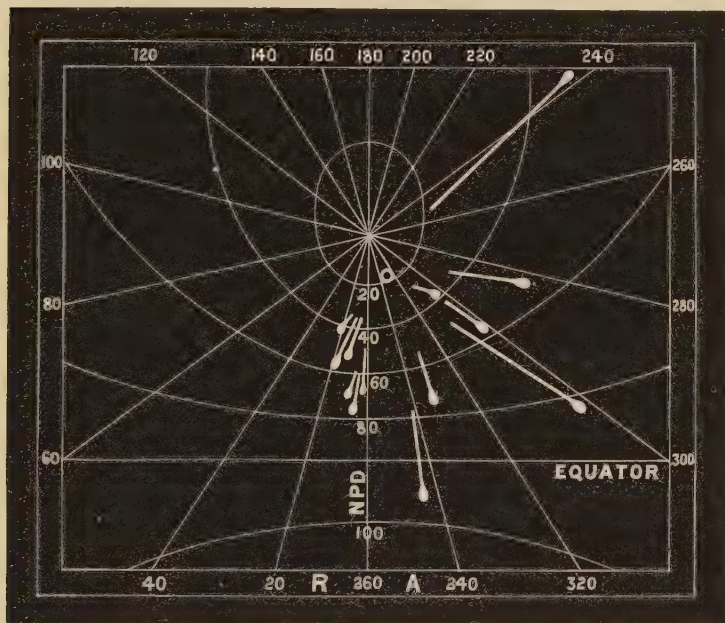


FIG. 1.—Paths of 13 Fireballs (Cepheids), Aug. 9-11.

amply confirmed from other sources. On August 10, 1869, Mr. Backhouse, at Sunderland, saw a bright stationary meteor at 337°+78°, which obviously belonged to this stream, and on August 10, 1874, a fireball was observed by Prof. Herschel, at Newcastle-on-Tyne, and Mr. Clark, at York, which gave a radiant point at 352°+72°.* Another meteor doubly observed on August 11, 1871, at Greenwich and Hawkhurst, gave a radiant at 350°+70° (Waller), "the recorded paths being in very good accordance with a radiant near ψ or ι Cephei."† This position

* British Association Report on Luminous Meteors for 1876, p. 138.

† *Ibid.* 1874, pp 278 and 285.

has also been derived by several meteor observers as giving a contemporary display with the Perseids:—

August 9-12	...	$355^{\circ} + 81^{\circ}$ Heis (113 meteors)
5	...	$315 + 80$ Schiaparelli and Zezioli
6-31	...	$335 + 67$ Greg and Herschel
12	...	$330 + 70$ Denning
17	...	$335 + 69$ Corder
August	...	$340 + 67$ Greg (1874)

The mean of the six positions is $335^{\circ} + 72^{\circ} \cdot 4$, which is almost coincident with the fireball radiant above referred to. The point of divergence as given by different observers does not agree very closely, but the great altitude of this shower readily explains this, for a radiant near the zenith is always much more difficult to determine with precision than one near the horizon. I believe that the several positions included in the list certainly relate to one and the same stream, and this is rendered additionally probable by the fact that the average place exhibits so close an agreement with the fireball radiant which has been quite independently derived. And if further proof is needed as to the existence of this prominent shower of Cepheids, we have it in the observations of Mr. Clark, at York, on August 5-12, 1871, who, in summarising his results,* says, "A remarkable feature was the outlying radiants, one of which was situated at or near θ *Cassiopeiae*, and another near the star C of *Camelopardi*. The radiant between δ *Cygni* and γ *Draconis* was very well marked, also a radiant near γ *Cephei* [$353^{\circ} + 73^{\circ}$], where an almost stationary meteor was observed." The latter shower is unquestionably identical with the one we have now been describing, as the position and epoch are the same.

II. The fireball radiant near α *Cygni* is at $312^{\circ} + 50^{\circ}$, which is already well known as an apparently long-enduring shower visible chiefly in the months of July and August. Mr. Greg † places the centre at $309^{\circ} + 48^{\circ}$ from a mean of 15 different estimates, and calls it the *Cygnids I*. It is certainly a stream of considerable richness, and one which, though supplying many shooting stars of ordinary type, is also notable for the occasional exhibition of very large meteors. In looking through the published observations of August 9-11, I found the paths of twelve fireballs which conformed more or less exactly with this radiant, and the observed positions of nine of these are projected on the following diagram.

* *Nature*, August 17, 1871.

† "Table of Radiant Positions and Durations of Meteor Showers visible in the Northern Hemisphere," published in the B. A. Report on Meteors for 1875, p. 159, Radiant No. 81.

Though this shower has not, I believe, been hitherto noticed as affording a conspicuous display of brilliant meteors, it has been seen as a well-defined radiant by nearly all regular observers of meteor showers. Greg and Herschel gave the centre as at $310^{\circ}+47^{\circ}$ (July 6-August 4), Schiaparelli and Zezioli at $304^{\circ}+49^{\circ}$ (July 31) and $304^{\circ}+44^{\circ}$ (August 4), Corder at $304^{\circ}+48^{\circ}$ (August-September), while the writer found it at $315^{\circ}+50^{\circ}$ (July-August 1877). Tupman gives a shower at $310^{\circ}+58^{\circ}$ (August 13), but this is too far N. to be fairly con-

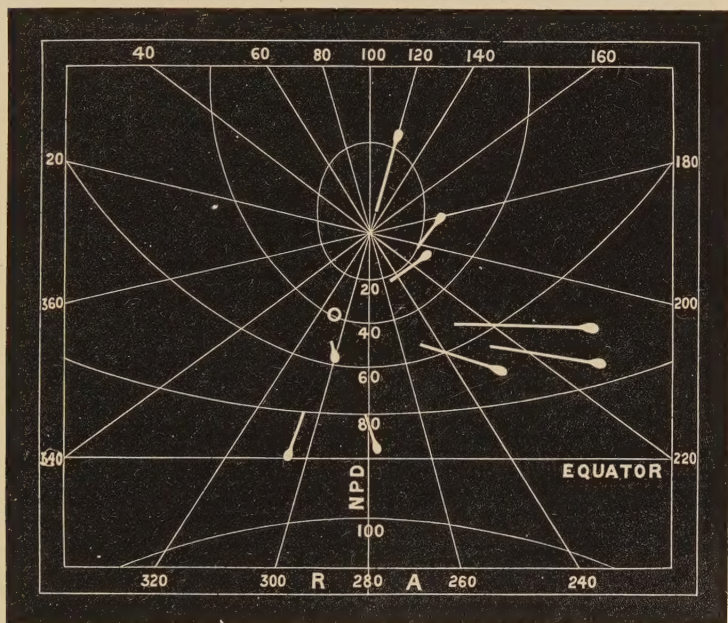


FIG. 2.—Paths of 9 Fireballs (Cygnids), Aug. 9-11.

sidered a return of these Cygnids. It undoubtedly refers to a northerly radiant in *Cepheus*, which we shall refer to later on.

In *Cygnus* and the immediate region hereabout there is a large number of contemporary showers, visible in July-August, which are very liable to confuse observers. Some of these showers lie in the more southerly part of *Cygnus*, others cluster about a *Cygni*, and others again extend northward into *Cepheus*; indeed, this region of the heavens appears to be so rich in meteor streams at this epoch that it is extremely difficult to disassociate them. In comparing the radiants given in various catalogues, they seem to be so numerously distributed in this quarter that it is impossible to group them into reliable positions. I believe, however, there are three active showers here to which the

majority of these observations have reference, and I have derived the following mean positions for July–August:—

(1)	$311^{\circ}5 + 47^{\circ}0$	α Cygnids, mean of 18 radiant.
(2)	$310^{\circ}4 + 36^{\circ}0$	ϵ Cygnids, mean of 14 radiant.
(3)	$311^{\circ}8 + 62^{\circ}3$	α Cepheids, mean of 14 radiant.

There are other and probably less active displays at this period of the year, both from *Cygnus* and *Cepheus*, while E. and W. in *Lacerta* and *Lyra* the sky is teeming with meteor showers. The shower at $311^{\circ}8 + 62^{\circ}3$ (α Cepheids), is quite a separate display to the shower at $335^{\circ} + 73^{\circ}$ (γ Cepheids), though its contemporary activity is evident. And the pair of showers near α and ϵ *Cygni* are no doubt equally distinct though not always distinguished from each other owing to their proximity of position. There is, however a difference of 11° in declination, which is sufficiently large to prevent confusing the meteors of the two systems, especially when the motions are chiefly in R.A., and the meteors appear in the region of their radiant point.

Amongst the bright meteor showers of August 9–11 I may refer also to the γ Andromedes ($12^{\circ} + 30^{\circ}$) and σ Draconids ($284^{\circ} + 62^{\circ}$), which are both well ascertained radiant points included in Mr. Greg's general catalogue (1875), where they are placed at $7^{\circ} + 33^{\circ}$ and $282^{\circ} + 60^{\circ}$ from a mean of twelve positions each. It is to these and to the contemporary showers of Cepheids and Cygnids that many fine meteors (non-Perseids) of the August epoch owe their origin. Observers of future returns of the Perseids will, therefore, do well to note the paths of such fireballs as are not conformable to *Perseus*, so that they may be attributed their separate radiant points, and the investigation of these interesting minor showers carried yet further.

Bristol: 1882, Nov. 1.

The Electric Light in Observatories. By W. S. Franks.

I wish to bring under the notice of this Society a simple, cheap, and efficient means of obtaining illumination; equally applicable to the micrometer, divided circles, clock face, reading desk, &c. The light is so thoroughly successful that I feel sure it only requires to be made known, and I have Canon Beechey's permission to state freely what I saw of its action in his observatory (Hilgay Rectory, Norfolk) during a long night's work. Two of Swan's smallest incandescent lamps were in use, one for the reading desk and the other in micrometer; and, as they are never required to be both used at once, a switch directs the current from one to the other. The battery consists of four pint-size bichromate cells, the plates being 6 in. $\times$ 2 in. A

wooden frame supports the plates, and a catgut line is fastened to its centre, then passes over a brass pulley, and is attached to a leaden counterpoise, which just balances it. Thus it will be seen that the plates can be depressed or raised, and the light correspondingly regulated to the utmost nicety. To give an idea of how the light can be reduced, I measured the 13 mag. comes to P. I. 145 *Piscium* with ease, with bright field illumination (the telescope is a 10-inch Calver). The lamp over the books was very beautiful, and pleasant to read by; and an abundant length of flexible silk-covered wire enabled it to be carried about anywhere in the observatory, for reading off the circles of equatorial, clock dial, &c. A spare battery is in reserve, in case the light diminishes after long use, but the worked battery is as good as ever after a few minutes' rest. It is necessary to be careful about the carbon connection; but a slip of platinum foil next the carbon, and a slip of brass between it and clamp screw, makes all safe against oxidation. It is almost unnecessary to add that I am now converting my own from oil to electricity, and earnestly advise others to do the same.

Leicester: 1882, Nov. 1.

On a Probable Assyrian Transit of Venus. By the Rev.
S. J. Johnson, M.A.

That a solar spot 1' of arc in diameter may be perceived by unaided vision will readily be granted. Consequently little notice need be taken of M. Arago's remark that "naked-eye observers of the transit of 1761 made more use of their imagination than of their eyes," especially as distinct mention is made of *Venus* being so seen by Mr. Holland at Quebec in 1769, and at Maros Vasarhely and other places in 1874. Conjunctions of *Venus* and the Sun are noted down in Stöfler's Ephemerides at the time of the transits of 1518 and 1526; but even if the idea of one had occurred, his tables show too great a distance between the planet and the Sun. As to the solar spot said to have been seen by Averrhoës in 1161, when *Venus* was in conjunction, it may be remarked that in the list of the transits given in Ferguson's Astronomy from La Lande's tables, only a single transit seems to have occurred in the twelfth century, in 1153. There is, however, one instance in very ancient times which may turn out to be a transit. A broken Assyrian tablet, just mentioned in a note of two lines by Rev. Mr. Sayce in "Nature" some years back, may perhaps deserve more attention than it has received. As the tablet is concerned with the planet *Venus*, and as the following succession of broken lines occurs, "the planet *Venus*"—"it passed across"—"the Sun"—"across the face of the Sun," it naturally occurs to try to fill up each hiatus. But it seems very difficult to explain the last sentence otherwise than by supposing that an actual transit is recorded, which, it seems,

must be before the sixteenth century B.C. It reads like a case of an *entire* transit visible in Babylonia.

Melplash Vicarage, Bridport :
1882, Nov. 7.

The Solar Eclipse of 1882, May 17, observed at Meerut, India.

By Major Alex. Burton-Brown, R.A.

On the morning of May 17, 1882, a party of officers, under my supervision, set to work to construct a small observatory of laths, and arranged our telescope on a fixed pillar, so that the Sun might be projected on a screen of paper forming a plane perpendicular to the axis of the telescope, and moving with it, all other light being shut off from above except what passed through the telescope by means of another upper screen attached thereto.

The telescope was a refractor, with a fine object-glass of $2\frac{3}{4}$ in., and a power of 50. The projected image was 6 inches in diameter.

First contact was very clearly marked on the screen at $11^h 58^m 36\frac{1}{2}^s$ local time, but the exact moment of maximum eclipse cannot be certainly stated, but is believed to have been at about $14^h 7^m$. A sketch was made when the Moon was just commencing to occult the large group of Sun spots, the largest of which were nearly as black as the Moon; far darker, by comparison, than I have ever noticed them in former eclipses. A few minutes after we clearly noticed the retrogression of the shadow.

The rugged edge of the Moon was seen to great perfection, as also first contact with great accuracy on the paper screen; far more so than by direct-vision observers with dark glasses. The occultation of the spots and the comparative degree of darkness between them and the Moon were most clearly noticed. Very faint clouds were noticed, but not in the vicinity of the Sun, at the commencement of the eclipse. As the eclipse progressed, they increased and approached the Sun apparently, and about 2 o'clock a few passed over the Sun. As the eclipse passed off, so the clouds receded and disappeared entirely before the eclipse terminated.

The maximum temperature in the sun was $159\frac{1}{2}^{\circ}$ F. The temperature in the shade was 102° F. at noon, and 93° F. at 2 p.m., showing a fall of at least 9° F. during the eclipse.

I would observe that in any place where a clear bright sky was obtainable, and where the sun was at a considerable altitude during the Transit of *Venus*, unscientific observers might do good service with 3-in. or 4-in. refractors and powers of 35 to 60, by marking the track of the planet on a 6 or 8-inch image projected on paper—say every quarter of an hour. These, when compared and tabulated, would form a useful auxiliary to the regular observations.